BACKGROUND

The use of prescribed fire in Ontario, Canada, has been a part of the normal resource management program since the late 1950's. The program has been regarded as an effective and relatively inexpensive method of accomplishing forest and wildlife objectives. The Forest Management Program increased its targets substantially in response to a need for more forest regeneration. Increasing costs of mechanical site preparation have placed more emphasis on prescribed burning as an alternative site preparation method. The Forest Management and Fire Control organizations have committed to an expanding program. Advances in training, technology, and methods applied to prescribed burning along with staff interest and commitment accounts for the increase in prescribed burn outputs.

The PB-3 burn was divided into three separate blocks. Block A was 25 hectares, Block B was 35 hectares, and Block C was 60 hectares. Main tree species on the area were balsam fir, white spruce, and black spruce, with a small amount of white birch. The purpose of the burn was to prepare the site for hand planting. The area was clear-cut in 1979 with some thickets of balsam fir left as residual stands. The topography was flat to rolling.

The area to be burned was selected in the fall of 1978. This gave District Staff enough time to visit the site several times during the planning period to examine fuel and topographic conditions, and to prepare the plan prior to the 1979 operating season. Only part of Block C had been cut at that time. Several visits made during the winter resulted in some modifications to the plan which were intended to enhance the burning operation.

There was good cooperation in the plan development. The silviculture prescription was prepared with consultation between Forest Management and Fire Control staff. The prescription would achieve the results required to prepare the area for regeneration.

The data from the fuel sampling plots established by Forest Management and Fire Control staff were not compiled prior to the burn. The fuel loading appears to have been an important factor affecting fire behavior in this case.

The fire prescription was developed from the Canadian Forest Fire Danger Rating System (CFFDRS). The selected prescription was tested with two computer programs designed for the purpose. One, called PBWX, is based on historical fire weather information that is used to predict an expected number of days a

particular range of fire prescriptions should occur. The second part, called PBPJ, used the Fire Behavior Index tables from Supplement ONT-I of the CFFDRS to predict fire behavior for given codes and indices.

The test indicated that predicted fire behavior would be manageable with an intense, rapidly spreading fire expected at the maximum prescription.

Table 1 compares the codes and indices prescribed with those actually experienced on the day of the burn (August 22, 1979). Most actual values are somewhat lower than the prescribed values. The actual values are adequate to permit slash burning. The planned prescription is acceptable.

Table 1
Comparison of Codes and Indices - Wawong Lake Fire Base

Code	Prescribed	Actual Aug. 22/79
Fire Fuel Moisture Code (FFMC)	87 - 92	84
Duff Moisture Code (DMC)	30 - 50	16
Drought Code (DC)	100 - 150	295
Build Up Index (BUI)	28 - 48	27
Initial Spread Index (ISI)	5 - 8	3
Fire Weather Index (FWI)	10 - 20	6
Relative Humidity (RH%)	0 - 50	62
Windspeed(km/hr	0 - 7	9
Direction	SE - S/SW	South

IGNITION TACTICS

In order to clearly understand the ignition sequences on PB-3, it is important to keep in mind the feelings of key personnel with respect to burning conditions. Forecasted poor weather and moderate CFFDRS codes and indices were key factors explaining the choice of ignition pattern, which was actually somewhat different from either of the two specified in the approved plan. To the senior staff, all indications were that difficulty in obtaining adequate fire behavior would be encountered.

Perhaps the single most crucial question in this entire investigation is why Dalton and the young people with him were on the inside of what eventually became a ring of fire instead of on the outside. The answer must lie in the basic misunderstanding as to the ignition pattern and its execution between Dalton on one hand and Hilliard and Reynolds on the other.

Hilliard and Reynolds (positions A & B) had decided on a U-shaped ignition pattern open downwind to the north. This would be well suited to the situation of Block C, with an essentially non-combustible area to the east, west, and north. There was thus no danger of downwind fire escape, and no reason to secure the downwind side. The U-shaped pattern would be, in effect, midway between a conventional strip pattern and a complete circular or convection style ignition (both were specified as choices in the approved plan). It would tend to burn out the area enclosed more effectively than a straight line of fire, an especially desirable consideration on a day when, as most people thought, burning would be slow and difficult. This pattern could furthermore be repeated as often as necessary at intervals progressively upwind.

Dalton, (positions 3 on slides one through four and W on slide five) although directed in some manner to the northeast side of the hill, had incomplete knowledge of where other people would be igniting. He apparently pictured, not a multiple "U" shaped ignition, but rather a series of strips progressively backward into the wind, of which his ignition along the northeast green edge would be the first. Once it was completed, he and the others would simply back up into the slash and repeat the process. It was thus understandable for him to light a line of fire between himself (along with the young people) and the green timber edge, never imagining that he should have been on the other side of it. Furthermore, smoke was drifting (at first) into the swamp rather than into the clear-cut. It would simply not have made sense to ignite from the smoky side rather than the clear side. Meanwhile, Reynolds thought that Dalton and his group would ignite as they proceeded, turning off to the east once they reached the green timber. They would then have been safely out of the way when the south side of the "U" was ignited.

While Dalton and the young people ignited downwind, others were directed to ignite at positions 1, 2, 4, and 5 at approximately the same time. Dalton and the young people were firing not knowing their escape routes had been cut off by the other firing operations. The bodies of the young people were found at position b.

One obvious principle in prescribed burning operations is that no ignition takes place anywhere upwind of anyone operating within a danger zone downwind. Certainly no south side ignitions would have taken place had anyone realized that Dalton and the young people were within the "U". It was thus the initial communication process that failed. Although the ignition plan was strategically sound everyone did not understand his role nor, more particularly, the role of others in the ignition process

Another logical safety principle is that any ignition line not basically across the wind should be lit proceeding upwind rather than downwind. This principle was broken twice at PB-3. Ignition was lit without serious consequences downwind, but the second instance contributed to the final tragedy. Had Dalton and the young people proceeded first to the far end of their eventual ignition line, then ignited on the way back, they could have moved out of harm's way as they approached the southeast corner. That they actually ignited while proceeding north (with the wind) was the result of the basic misunderstanding referred to earlier.

Also of significance is the fact that there were 14 people immediately involved in lighting fire in the initial ignition sequence in Block C, all in a confined area of 2.5 hectares. This alone would present management and communications problems, as well as establishing a large amount of fire in a very short time. More specifically, the eight persons involved in ignition on one small portion of the fire (northeast side) would be difficult to supervise.

In summary, it is apparent that a "U" shaped ignition pattern could have been established quite safely at PB-3 by sending two parties to the downwind ends, each of whom would return igniting from the outside along their respective arms of the "U" until they met at the upwind center near the staging area. As it turned out in the actual operations, the safety principles were violated in the following ways:

1. Ignition 1 was set while proceeding downwind rather than upwind.

2. The south side ignitions were lit before Dalton and his group were known to be out of the downwind zone.

3. Ignition 3 (Dalton's) was set while proceeding downwind rather than upwind, and from the inside of the "U" rather than the outside. The crucial misunderstanding behind this has been described.

4. The beginnings of a second pattern (ignitions 7 and 8) were begun before all parties involved in the first were accounted for.

The key ignitions took approximately 4 minutes, a time so compressed that Reynolds and Hilliard had no time to react to trouble, and nothing could be done to avoid the accident that happened 4 or 5 minutes later. By the time cries were heard at about 1219, it was too late, and any number of suppression crews on site could not have prevented the final result.

ENTRAPMENT

Just after noon on Wednesday, August 22, 1979, seven young people lost their lives 7 minutes after ignition within a prescribed fire known as Geraldton Prescribed Burn No. 3 (PB-3). The detailed movements of the seven young people can, of course, never be known. It is only certain that they did eventually come together in a balsam thicket where they were finally found. The key point is that Dalton and the entire group were igniting fire between themselves and the green timber. It is reasonable to suppose that as Dalton ignited northwesterly along the green timber edge, the young people remained behind him, helping with the ignition (all had matches) as they went. Once Dalton sensed trouble, he shouted to the young people to follow him. The whole group may perhaps have converged uphill somewhere north of a balsam thicket, attempted under Dalton's urging to follow him, but were unable or unwilling to face the radiational heat from the north and the prospect of plunging through fire. They would then have been forced south into the balsam thicket seeking shelter, to be caught soon afterwards by the fires from the south and west. Meanwhile, Dalton, finding himself alone, forced his way through the only possible escape route at the last possible moment.

Recommendations

The Board of Review listed the following recommendations after their analysis of the PB-3 situation:

1. Prescribed burning continue as an important part of the site preparation program in Ontario in general and in the Geraldton District in particular.

2. A comprehensive Prescribed Burn Manual be compiled using the best and most current information available and that a target date of February 15, 1980, be established for completion of the prototype manual.

3. Concurrent with the compilation of a manual, a prescribed burn training program be developed with the objectives of having a course ready for presentation by April 1, 1980.

4. Staff in charge of prescribed burning operations be trained specifically in all available means of predicting the behavior of prescribed fires in various slash fuel types.

5. A formal step-by-step system be developed for predicting fire behavior in slash, incorporating the major pertinent factors such as species, fuel quantity, slope, and ignition pattern.

6. The use of test fires be discontinued as a means of judging the behavior of prescribed fires, and that the ignition sequence itself must be designed so that plans can be modified as a result of the behavior of the first ignitions.

7. As a part of a thorough on-site briefing, just prior to ignition of prescribed burns, ignition personnel be informed not only of their own responsibilities, but also of the proposed actions of other ignition crews in the overall ignition sequence.

8. The number of persons per ignition crew be kept to a maximum of a crew boss plus three ignitors.

9. As a general principle, no ignitions should take place upwind of persons operating downwind, and all ignition lines should be established while moving into or across the wind.

10. Ignition crews must be familiar with the prescribed burn site, escape routes, and safety zones.

11. The Ministry expand its program for developing ground and aerial ignition devices in order to minimize the number of personnel involved in ignition.

12. As many preparations as possible be made at early stages in the planning process (e.g., establishment of control lines, pre-selection of primary and alternate participants, and preburn site inspection by all potential participants).

13. However, short the preparation time available, all essential details should be considered before ignition, even if the opportunity to burn is lost. Further, to ensure the consideration of all details, a mandatory checklist should be developed and included in the Prescribed Burn Manual.

14. The Ignition Boss has guaranteed voice contact (radio) with the person responsible for each segment of the ignition so that he can direct the ignition timing, monitor ignition progress, order modifications, or give emergency instructions as required.

15. All participants, in any prescribed burn, be briefed in detail immediately before ignition on such points as ignition locations and sequences, suppression plans, access, escape routes, safety zones, anticipated fire behavior, potential problems, and emergency procedures. Briefings should include the provision of detailed maps and site inspection.

16. A careful analysis of manpower requirements be made for every prescribed burn with the objective of holding on-site numbers of people to a minimum.

17. People assigned to key prescribed burn implementation roles such as Fire Boss, Ignition Boss, Suppression Boss, and the representative of the client program must be intimately involved in the preparation of the plan and familiar with the area at be burned.

18. Qualified alternates for the key implementation roles be assigned to the planning process for each prescribed burn at an early stage.

19. A senior Fire Control person or a qualified Fire Safety Officer be a member of the planning team to fill the safety audit function and take an active part of the prescribed burn.

20. A minimum of Unit Crew training be required for all personnel involved in prescribed burning ignition and suppression, including Junior Rangers and Experience students. This does not exclude untrained staff from being used in support roles.

21. A moratorium be placed on the use of Junior Rangers and Experience students for prescribed burn ignition and suppression operations (until No. 20 is put into effect).